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Hypertext:
A New Method for Analyzing
Educational Computer Conferencing

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HYPERTEXTUAL TRANSCRIPT ANALYSIS OF EDUCATIONAL COMPUTER CONFERENCES

INTRODUCTION

Educational applications of computer conferencing is a new phenomena, beginning only in the early 1980s. However, it has already been rapidly adopted for group learning interactions at all levels of education, from primary school to graduate level courses and programs. Research methodologies and approaches are needed to study this educational phenomenon, to inform and advance developments in the field.

In this paper we propose a methodology for analyzing transcripts of online educational conferences. The method which we are developing investigates and links content and types of cognitive and affective interactions used by participants in online learning collaborations. We also present a system for labelling and categorizing processes in collaborative learning. Preliminary data generated from the use of this method are included.

USING COMPUTER-BASED SYSTEMS FOR ANALYSING COLLABORATION AND COGNITION

Hypertext systems are a new genre of computer software in which the basic metaphor of the system design is the information storage, retrieval and processing of the human brain. Some of the user interfaces which hypertext systems provide are:

- textual information stored in "nodes" which can be displayed either in a network or graphically. The textbase can be pre-defined or input by the user and thereby provides authoring facilities.
- "link icons" which are pointers that allow the user to browse or navigate through a corpus of information. In this way it is possible to follow the interconnectivity of ideas in the system. These may be pre-defined or the user could enter the necessary links in the system.
- "searching" capabilities that are defined at each node in the form of keywords which can be used to retrieve information from the text base.
- "windows" which can be used to correspond to information entered in each node and are opened when a particular node is retrieved.

Hypertext and information management systems can be applied to analysing computer conferences, as a means of providing a better grasp of overall content and structure of a conference in progress. Computer conferencing systems currently have only rudimentary forms of information structuring capabilities, which are inadequate for identifying and displaying content and process linkages within a conference or set of conferences (Harasim, 1989; Wolfe, 1989).

Here we explore the use of hypertext systems to analyze an educational computer conference. Our approach integrates interaction analysis and content

analysis of the communicative acts of the members of a group. The content analysis of a computer conference concerns the qualitative determinations of what was said. The process analysis links this information with who said what, and when in the chronological or logical sequence things were said.

In this paper, two information structuring systems (STORYSPACE-hypertext, and IZE - information management) are applied to the analysis of educational computer conferencing transcripts. We consider system features for such an approach and explore issues in using this genre of computer-based systems for analysing group interactions within computer conferencing.

Hypertext systems offer the researcher a means for analysing the knowledge building processes of the learner. Like information management programmes, they can be used to identify, link, and label various cognitive and affective skills and strategies carried out by individuals involved in the process of online collaborative learning.

Since most hypertext systems enable an overview of the nodes and links, the researcher would obtain an abstracted representation of the interactions (this is frequently in the form of a graphic mapping). Such a representation provides a means of observing the interrelationships of ideas in an online conference and has value for both quantitative and qualitative assessment of the interactive processes.

Moreover, hypertext programs enable viewing the thematic and process interactions in various configurations (from different combinations and perspectives) in order to study what occurs within online learning groups. This method is valuable for both exploratory and full data analysis of text-based content. Here we use it primarily in exploratory mode where it provides a "snapshot" of various types of collaborative learning interactions in a conference, a perspective valuable before deciding where to do further analysis or to investigate particular themes or processes.

Webb (1982) notes that observation procedures for studying student interaction and small-group learning in face-to-face environments are inadequate:

> Because detailed information about peer interaction is needed, verbatim audio or video record may be essential. Observation systems, whether time-based rotating sampling systems in which a single student is observed at a time, or systems in which all students are observed simultaneously, are unsatisfactory for several reasons. First, it is difficult to reliably distinguish between explanations and terminal responses without hearing the same response several times. Second, it is difficult to capture sequences of interaction among the different members of a group, particularly when one student's request for help and another student's response are often separated in time or by other interaction. Finally, in classroom settings, in which multiple groups typically work simultaneously, verbatim recording can capture most or all of group interaction, whereas an observer watching the group may have difficulty distinguishing voices or understanding what is said. (Webb, 1982, p. 170).

Transcript analysis is particularly appropriate for online educational activities, since an exact verbatim record of the proceedings is automatically

generated by the computer. Online education is text-based: all communication and interaction among participants (among learners and between learners and instructor) is conducted online. mediated (and recorded) by computer.

LEARNING PROCESSES AND STRATEGIES

One of the perennial challenges for educators is the identification of situations in which it is possible to help learners develop and use higher cognitive strategies. These skills are needed for enhancing independent. creative and problem-solving thinking, as well as basic computational and decoding tasks (Chipman and Segal. 1985). Educational research suggests that learning processes can be categorized into types and phases. One such categorisation is a three-phase process: (1) knowledge acquisition. (2) problem solving,[1] (3) and self-monitoring the knowledge building process. (Chipman and Segal. 1985)

The cognitive skills associated with **knowledge acquisition** are believed to assist the learner in assessing their knowledge levels by identifying when they know, what they know, what they need to know. and the manner in which new knowledge can be acquired (Brown. 1980; Pace. 1985). Some of the overt techniques used by learners in knowledge acquisition are *stating positions on a given topic, self-questioning, asking questions of others, and answering questions* posed by others on the information being studied.(Segal. 1985) Other processes are *introducing new points and perspectives, accepting or disagreeing with stated positions* based on the learner's prior knowledge.

The second category is **knowledge integration**. This is thought to be achieved when the individual uses prior (acquired) knowledge to process new information (Bartlett. 1932). As a result, the learner makes perceptual alterations about all new information which is then incorporated into new postural models. (Holland, 1987; Schank and Abelson. 1977; Bartlett. 1958) And it these models that can help to advance the knowledge building process. (Holland. 1987). Some of the cognitive skills used in knowledge integration are changing information by *analysis, clarification, synthesis, modification, hypothesis formulation and testing, qualification, rearrangement, elaboration, translation, integration, generalisation, abstraction, searching related knowledge and keeping track of progress.* (Bartlett, 1958; Bruner, 1957; Ausubel, 1968; Polson and Jeffries. 1985)

The most pervasive strategy in knowledge integration is *elaborations*. It is through elaboration that that readers are able to learn most from text based materials. (Weinstein, 1978; Weinstein and Underwood. 1985). This is thought to involve the use of *verbal and imaginal elaborations* by individuals involved in active learning. Some of the specific strategies used in elaborations are *imagery, analogies, and generating inferences.*

The third category represents the mental functions that the learner uses to order all new information and the learning process. Since the learner controls the interaction with the new information, the strategies used are essentially

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[1]*Since this process contributes to the overall incorporation of new knowledge into existing base of the learner, the term* knowledge integration *will be substituted for this process throughout this paper*

self-management or self-control mechanisms[2] (Chipman and Segal. 1985: Baron. 1978: Sternberg, 1982). Some of the strategies used in this process are imposing limits on the learning situation. organising tasks into manageable chunks. subject organisation. grouping of themes or concepts and checking the outcomes of the learning process. (Baron. 1978)

Specific organisational strategies used in relating to new information by reading, listening or speaking appear to be related to the task that is being performed. For example. some of the organisational strategies used by the reader to gain a greater understanding of the content in text-based materials are *note taking, underlining and highlighting* (Cook and Mayer. 1983: Jonassen. 1985).

The use of these strategies with traditional text-based materials has been documented extensively. The innovative use of electronic communication for conducting online education has meant that some investigation of the organizational skills used by participants in reading from electronic text can be explored. Work done by Harasim et al (1989) shows that readers text in online courses also use various organizational strategies in putting some structure to online discussions: these include saving to diskette. filing electronically. or categorising in manila folders.

The main difference with the use of these strategies in computer conferences is that the organisation is done external to the context in which the text is being read and generated. For purposes of this study these organisational strategies which the participant uses offline would not be studied. Rather. the emphasis would be on the online learning interactions that occur among users.

Another aspect of the knowledge building process is the affective component of learning. The relationship between affective and cognitive strategies is discussed by Rokeach(1960) who states that:

> ... analysis in terms of beliefs and systems of beliefs does not necessarily restrict us only to the study of cognitive behaviour. We assume that every affective state also has its representation as a cognitive state in the form of some belief or some structural relation among beliefs within a system. ... In all cases, enjoyment or its opposite is the affective counterpart of a belief organization and can be thought of as being in one-to-one relation (isomorphic) with it. Thus. our cognitive approach is as much concerned with affection as with cognition. (pp. 399)

Affective strategies used by learners are *receiving, responding, valuing, organization and the development of a value complex* (Krathwohl et al. 1974). Through the use of affective learning strategies individuals are able to receive motivational and emotional support for learning (Spielberger et al. 1979). Webb (1982) suggests that the use and development of socio-emotional strategies by the individual is an essential aspect of effective learning. Some of the skills used in attaining these outcomes are thought to be *giving positive or negative reinforcement, and others.*

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[2] *These processes are different from those used in the knowledge acquisition phase in that the learner is able to monitor both cognitive and affective skills and strategies used in learning as well as the organisation of the task.*

The stored messages in online education provide an environment whereby the cognitive and affective strategies used by participants can be studied. For purposes of this study, the categories of learning investigated are:

COGNITIVE DOMAIN[3]
acquisition

* knowledge
* knowledge integration
* elaborations
* self-monitoring processes

AFFECTIVE DOMAIN

* socio-emotional skills

COGNITION AND COMPUTER CONFERENCING.

In computer conferencing the learner has ongoing access to the views, comments and perspectives of other participants through the stored messages in the system. As the medium is both time and place independent, there is an equal ability for participants to interact with all messages in the information base. Through feed-back from other participants, individuals can also clarify and/or expand on their perspectives.

Our approach employs interaction analysis to track the learning skills and strategies used by learners in online education. Some of the cognitive and affective skills and strategies used to enhance the communication process in a group setting for professional development are *interpretation*, *substantiation*, *extrapolation*, *exemplification*, *clarification*, *modification*, *agreements and disagreements* (Fisher: 1974). These processes are thought to be used whether the task being executed is decision making or problem solving in nature.

For purposes of this investigation, the preliminary list of items which were identified by the research team as observable cognitive and affective strategies were:

* translation
* interpretation
* extrapolation
* abstraction
* cognitive restructuring
* positive feedback
* generate hypotheses
* synthesis
* analysis
* formulation
* substantiation
* answers questions
* negative feedback
* test hypotheses
* interpretation
* substantiation
* clarification
* modification
* agreement

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[3]*The category of self-monitoring processes will not be explored in this study since it would go beyond the scope of hypertextual analysis.*

HYPERTEXTUAL TRANSCRIPT ANALYSIS

Our pilot work with hypertextual transcript analyses is described and presented below. The steps followed were:

1. Selecting the Software for Hypertextual Analysis
2. Selecting a Conference for Analysis
3. Identifying Descriptors for the Thematic Analysis
4. Identifying Keywords for Interaction Analysis
5. Structuring the Information for Hypertextual Analysis
6. Thematic and Interaction Analysis of the Conference

Selecting the Software for Hypertextual Analysis

To select appropriate hypertext systems for the transcript analysis, we examined six hypertext systems that are commercially available. The following criteria were used to evaluate the suitability of the system for our purposes. The hypertext systems should be able to:

- create links among entire notes as well as parts of notes.
- provide an hierarchical and/or graphical display of the linkages in the file.
- be customised to allow for the entry of keywords describing the learning strategies used by participants for the linkages and semantic descriptors for themes which would facilitate both thematic and interaction analyses.
- facilitate the simultaneous use of multiple windows so that related notes could be viewed at the same time.

Six different hypertext systems were investigated for the purposes of conducting the transcript analysis. The systems ranged from *concept mapping* tools such as LEARNING TOOL, to *information management* systems such as TORNADO and IZE, to fuller hypertext systems such as STORYSPACE.

Of the five commercial systems investigated, two were selected: STORYSPACE and IZE. STORYSPACE runs on a Macintosh, while IZE runs on IBM and IBM-compatibles. Our experience with HYPERCARD, LEARNING TOOL and TORNADO, was that the programmes did not provide the capabilities to view the interaction in either a graphical form nor in the hierarchical arrangement of linked concepts.

STORYSPACE is an hypertext system which is able to graphically represent information in a linked information base. This is done in either an hierarchical manner or as a chart. The programme allows the user to create links

from one note to another but does not facilitate the creation of links from a specific part of a note to another specific part of a different note.

STORYSPACE enables searching and sorting of the information base with considerable ease. By using Boolean searches it is possible to quantify the number of references to concepts; to track the cognitive interactions that were used by participants in referencing messages in the conference, and to determine the frequency of particular learning interactions with each concept raised.

IZE is an information management system which presents information textually and hierarchically. The programme provides no means for doing graphical representations of links in the system. While it is essentially an information management tool, it provides a rudimentary linking system (not however of the complexity of most hypertext systems). However, like hypertext systems, there are excellent navigation tools in the programme that allow the user to move to any note in the system and/or create links between any part of a message to any other part of another message.

Choosing a Conference for Analysis.

The Ontario Institute for Studies in Education offers graduate-level courses entirely online. These courses are time and place independent (that is, students are located in urban and rural areas throughout the province or country, and are linked by using their computer as a communication device), and are typically structured upon group learning approaches. For the purposes of this study, we selected an online "seminar" in which students used the computer conferencing system for group discussions related to these readings.

We selected one conference (out of three concurrent "seminars") which ran for a period of one week. The three concurrent conferences or seminars were each related to the use of computer networking in a particular educational setting: "School Nets", "University Nets" and "Teacher Nets". Each conference had a specific number of participants (although in a few cases users participated in more than one conference. Nevertheless, each participant selected one of these conferences as their primary seminar.)

The second step was selecting one of the "seminars" for analysis. The selection was based on the following criteria. The text of the conference to be analysed should have a direct referencing of notes in the conference by participants. This would facilitate an examination of the **global** development of themes during a conference as well as the study of the **specific** manner in which participants formed online learning partnerships in each conference.

The conference which best matched these criteria was the "University Nets" which contained 72 messages. The readings assigned to participants in this conference focussed on the use of computer conferencing for university level education. There were 11 participants in this conference (a twelfth participated in this conference as a minor seminar) including the course instructor. The 10 students and moderator were the main commentators. The discussions on this topic lasted for one week.

Identifying Descriptors for Thematic Analysis.

To conduct a thematic analysis of the concepts generated in group discussion in a conference. all messages were read and key themes or concepts were identified. These concepts were then divided into two groups: concepts that came from the readings for that particular conference and concepts that were generated by the users in the online discussions.

The key concepts which were identified are:

FROM THE READINGS	FROM WITHIN THE CONFERENCES
- asynchronous communication	- peer feedback in CMC courses
- electronic university	- socio-economic levels
- interactive communication	- information overload
- role of the instructor	- metacognition
	- verbosity of participants
	- electronic training
	- entry skills of users
	- suitability of the medium
	- costs for using CMC
	- role of the learner
	- technical support

See Appendix A for a glossary of these key concepts.

Identifying Keywords for Interaction Analysis.

We began by fine coding the observable learning skills in the selected conference based upon categories identified in the literature. This exercise demonstrated that the initial list was not as exhaustive as it should be and had to be improved. The final list is as follows:

* asks a question	* clarification
* elaboration	* summarisation
* illustration	* substantiation
* new point	* agreement
* synthesis	* answers a question
* positive reinforcement	* states position
* catalysing	* new perspective
* exemplification	* formulation
* generating hypotheses	* disagreement
* abstraction	* modification
* negative reinforcement	* interpretation
* adopting course format	* proposing course format

See Appendix B for a glossary of these strategies.

Using the learning categories chosen for this analysis, the cognitive descriptors were classified as follows:

* **Knowledge acquisition**
  - asks a question
  - answers a question
  - introduces a new point
  - agrees with a perspective/position
  - states position
  - new perspective
  - accepts a stated perspective/position
  - disagrees with a perspective/position

* **Knowledge integration**
  - analysis
  - extrapolation
  - modification
  - illustration
  - exemplification
  - clarification
  - substantiation
  - abstraction
  - integration
  - translation
  - qualification
  - rearrangement
  - formulating hypotheses
  - synthesis
  - testing hypotheses

* **Elaboration**
  - summarisation
  - the use of imagery
  - the use of analogies
  - generating inferences
  - illustration

* **Socio-emotional**
  - positive reinforcement
  - negative reinforcement

Those processes that were used for proposing the course direction were put in the category of procedural activities. These are as follows:

* **Procedural**
  - Catalysing
  - Proposing course format
  - Adopting course format

STRUCTURING THE INFORMATION FOR ANALYSIS.

An important methodological issue is the manner in which the information is structured for the hypertextual analysis. STORYSPACE and IZE use the metaphor of a "notecard". Messages from the conference can be imported into the systems with each message forming a separate notecard. Two characteristics of the messages had to considered:

1. most notes discussed more than one theme and may have referred to a number of notes previously sent in the conference.

2. as there were multiple themes in each note. there was consequently multiple cognitive interactions emanating from one note.

Since STORYSPACE has no capabilities for multiple linking from one note to many others in its hierarchical features and since IZE could not display multiple themes of a single note as separate concepts, the messages had to broken down into separate parts based on the number of themes raised in the text.

This meant that for a message with four themes, for example a message which we would identify as note 34, each theme would be entered as a separate note. Notes 34A, 34B, 34C and 34D each dealt with a separate theme. While this would increase the number of cards created in the analytical tool, it would not increase the overall number of concepts discussed since each note would represent the themes actually raised in the messages sent in the conference.

The design features which determined the manner in which the information had to be structured for **STORYSPACE** also applied for **IZE** and the information was entered in the same manner. Further, since both systems provide the same type of searches and sorting facilities, it was possible to corroborate the figures obtained in STORYSPACE. It was also possible to obtain other information on the interaction process that was not available from STORYSPACE such as the frequency with which participants used specific cognitive interactions.

THEMATIC AND INTERACTION ANALYSIS OF CONFERENCE.

The analysis was conducted at two levels. The first was an investigation into the discussion of themes by participants in the conference. The second was to track the interactions among participants.

Each message in the conference was coded for the type of content and interaction. Only those notes which made explicit reference to messages that preceded it in the conference were coded with both thematic semantic descriptors as well as keywords describing the cognitive interaction used by participant. This information was entered into **STORYSPACE** and **IZE** and analysed to give the following data:

1. the frequency of concepts discussed.

2. the frequency of cognitive interaction processes used by participants.

3. the frequency with which the given cognitive interaction processes were applied to the different concepts raised.

4. the frequency with which notes in the conference were referenced by other participants.

RESULTS AND ANALYSIS

For the analysis with STORYSPACE and IZE, each note was split into any component themes. To generate an hierarchical arrangement of the interactions in STORYSPACE there must be a one-to-one mapping of notes. This allowed for the generation of an hierarchical representation of the discussion on **specific themes** but not of a **global representation** of the overall interaction which occurred. Since there were in some cases many-to-one and one-to-many mappings, such an hierarchical arrangement could not be generated. Nevertheless, a chart was produced which showed the interactions that took place in the conference (**see Appendix C**). With this chart it was possible to:

1. develop a pictorial representation of the learning interactions which occurred among participants
2. label the interactions made by each participant
3. examine the clustering by themes that took place in the conference
4. examine the patterns that developed based on notes that were frequently referenced and those which were not
5. observe the development of groups within the conference based on who responded to whose messages

To track messages sent by each user each note was entered in STORYSPACE by using the senders identification number. A pictorial chart of the online interaction could show whether "learning groups" were developing within the seminar.

In doing the analysis with IZE, listings of the themes and cognitive interactions could be derived by using various searching techniques (**see Appendix D**). From these listings it was possible to:

1. generate a hierarchy of the themes discussed and the cognitive interaction used by the participants on the themes
2. identify the frequency with which a user responded to a particular theme or used a specific cognitive strategy

STORYSPACE is able to give an hierarchical and graphical representation of the interaction among participants. However, it does not analyse the specific perspectives given of the themes discussed. On the other hand, with IZE it is possible to analyze the content of messages even though it is not possible to create a pictorial representation of the interactions.

Therefore each hypertext system provided the researcher with different features for analysing the information of the interaction processes used in online education. The tools serve a complementary role to each other in this form of analysis. Compared to a conferencing system, these two systems presented more explicit representations of not only the themes discussed by participants but also the interactions that occurred between them.

One of the benefits of using these systems for analysing the pattern of

interaction among participants was the ability to identify exactly which notes were referenced, the frequency with which they referenced, and by which participants. A tally of notes referenced in the conference (**See Appendix E**), showed that some notes were frequently referenced, while others were not referenced at all. Of the two messages most frequently referenced, one was a procedural message sent by the instructor. The other most frequently referenced message contained three new themes which were introduced by a participant. Of all messages sent in the conference, 46% were never referenced by other participants in the online course.

It was possible to divide all themes discussed in the conference into two main classes: those that discussed specific concepts from the assigned readings and those which were raised by participants in the conference. The themes discussing concepts from the readings accounted for 30% of all online discussion with "the role of the instructor" being the most frequently discussed theme in this category. (**See Appendix F**) All other concepts raised by the participants accounted for 70% of the online discussion with *electronic training* being the most frequently discussed theme.

In analysing the interaction processes used by participants in the online course it was revealed that the cognitive strategies accounted for 93% of all interactions made in the conference. The least frequently used group of processes was the affective categories which accounted for 0.9% of the messages in the conference. (**See Appendix G**)

An in-depth analysis of the cognitive processes used by participants showed that **knowledge acquisition** accounted for 50% of the cognitive interactions and 47% of **all** interaction processes used in the conference. (**See Appendix H**) Here the most frequently used strategy was *stating a position* while the least frequently used strategy in this category was *accepting a stated perspective/position*. Of all the knowledge acquisition strategies identified, the only skill which was not used in the seminar was *disagreement with a stated perspective/position*.

Knowledge integration accounted for 20% of the cognitive interactions and 19% of **all** interactions made in the conference. Here the most frequently used strategy was *extrapolations* with *exemplifications* being the least frequently used. Unlike the categories identified in knowledge acquisition, a much larger number of strategies for knowledge integration were not used in the seminar. These strategies were *abstraction, integration, translation, qualification, rearrangement, formulating hypotheses and testing hypotheses*.

The notion that **elaborations** are more frequently used in understanding information from text-based materials than knowledge integration strategies, is borne out in this study. Here 29% of the cognitive interactions made in the conference were elaborations and 19% were knowledge integration strategies. The most frequently used elaboration strategy was *generating inferences* with *illustration* being least frequently used. The strategies in this category which were never used in this conference were *the use of imagery and analogies*.

An examination of the interaction processes used in discussing the themes in the conference showed that of the 33 interactions made on those themes directly related to the readings, 16 (or 48%) were knowledge acquisition strategies. (**See Appendix I**) Of the other cognitive interactions made on these themes, 5 were knowledge integration strategies and 9 were elaboration strategies. The least frequently used strategies in these discussions were those falling in the socio-emotional category.

By examining those themes raised by participants in the conference it was observed that a total of 71 interactions were made on these themes. Of these. 34 were interactions which fall in the category of knowledge acquisition: 14 were knowledge integration strategies and 20 were elaboration strategies. 3 of the interactions processes fell in the category of procedural activities with socio-emotional strategies being the least frequently used class of interactions.

CONCLUSIONS and RECOMMENDATIONS

This investigation has served a two-fold purpose. First. it proposes a new methodology - hypertextual analysis - for analysing online communicative acts. Second. it provided a means of observing the types of cognitive interactions that occur among participants in an online course.

The findings from this study can be used to guide further research into:

- methodologies for analysing online conferences.
- structuring online conferences to augment the cognitive skills and strategies used by participants.

Proposals for these two areas are discussed separately.

THE METHODOLOGY

The development of criteria for evaluating the computer systems before the analysis proved successful since it facilitated an objective identification of the advantages and limitations of each tool. By pilot testing and identifying these limitations in advance it was possible to structure the information from the online conferences in such a manner that it could yield the most effective and efficient analysis.

The fact that the participants had pre-assigned readings for the conference eventually chosen for analysis meant that measurements could be made of the discussions of themes which arose from readings as well as on the themes introduced by participants. One of the difficulties experienced in this step was identifying categories which were mutually exclusive. Since this investigation studied the messages sent in a conference in which readings guided the structure of the interaction. it appears that some of the issues that need to be addressed are:

- Do conferences in which there are no pre-defined readings facilitate equal levels of cognitive interactions as those with pre-defined readings?
- How does the structure of the group involved in an online conference impact on the thematic interactions that occur among participants?

A further factor critical to the identification of the themes being discussed in messages was the intelligibility and cohesiveness of the content. Since the messages were written largely in the narrative mode, often one message would contain several concepts. In such instances. it was necessary to divide the reply

into its constituent parts based on the concepts raised. This meant that at the macrolevel, a global analysis of the development of ideas related to a specific topic could be done while at the same time, analyses of the specific topics discussed by each participant could be analysed at the microlevel.

Apart from the thematic considerations that guided the levels of analysis in this research project, earlier studies on impact of group work upon learning processes provided explicit parameters which could be applied to investigating the learning processes of participants in online education. However some of the methodologies could not be adopted in this study because of the low generalizability of the results of these investigations due to the:

- contexts in which previous research were conducted used face-to-face interaction in real time and done in business organisations. (Bales:1956)

- tests done to identify the cognitive impacts of the group work on the learner were specific to the classroom situation and task-oriented in nature. (Johnson & Johnson: 1982; Slavin: 1978; Slavin: 1980)

- investigations into the socio-emotional impacts of group work were done using gender, ethnicity, socio-economic and age as some of the parameters by which to measure the levels of interaction. These issues are not addressed in this study.

The identification of the learning strategies to be used for the analysis proved to be the most difficult part of this methodology. One of the major problems here was classifying a response based on the cognitive interactions used by the participant. For example, should a question that raises new perspectives in the conference be classified as "question" or "new perspective"? Further, how does one decide whether an interaction made by a user to another's message is an elaboration or an extrapolation? This demonstrated that:

- retrospective analysis of learning interactions in online educational settings are insufficient for fully determining the intent of the learning interaction used by the participant.

- there is a need for identifying and designing evaluation tools that can be used in both the real-time evaluation of learning in online courses which can be then merged with results gained from historical analyses of transcripts of messages sent online by participants.

- there is a need to identify what is the smallest "chunk" of information that is to be analysed in the transcript.

Some proponents in the field of cognition suggest that cognitive skills in learning suggest that there are external manifestations of the use of higher order and lower order skills in learners. The approach taken in this study is that there are some interactions in which the participant exhibits more knowledge building strategies based on the content sent in some messages than others. While there is no consensus on whether these categorizations in fact exist, for purposes of this study it was assumed that the levels of cognitive manifestations could be clearly defined.

Although we began with some cognitive categories/labels prior to the analysis, these were refined during the actual coding. Certain categories were eliminated and others added. Thus new categories were defined in an iterative process.

Findings in this study suggest that there is a need to:

- further identify and refine classes of cognitive skills and strategies for transcript analysis.
- develop new methodologies that could be used to track cognitive development of learners in a computer conferencing environment.
- determine whether external manifestations of cognitive interactions are different for the face-to-face and online educational environments.

THE INTERACTION PROCESS.

Hypertext systems such as STORYSPACE and IZE provide new media to make the interaction processes that occur in online course more concrete and more explicit to the researcher. The effectiveness of these tools for such analysis can be determined by the features they have making explicit the interactions that occur among participants in online courses. To provide this facility there appears to be a need to identify:

- methods by which the intent of referrents could be explicit (ie. the use of behavioral strategies such as key wording and references, or system features to facilitate accurate links).
- design interfaces which could be interfaced with computer conferencing systems in order to display to participants the type of interactions that are in fact taking place during online courses.

Information management tools such as IZE offer a means of disseminating results since analyses are generated in a text mode. Analyses of interaction (whether by learners, instructors, and/or researchers) could be uploaded and distributed to the online group for further comment and analysis.

An examination of the notes actually referenced in the system, shows that there are some messages which are frequently referenced, those which are less so and those which are never referenced. The results indicate that a significant number of notes were never referenced by other participants in the conference. Closely related to this finding is the fact that 51% of all interactions made in the online discussions involved the use of **knowledge acquisition** strategies and 0.9% of all interactions were socio-emotional in nature. Some of the questions that arise in bringing these two pieces of information together are:

- Is there any relation between the un-referenced notes and the knowledge acquisition strategies used by participants?
- What are the socio-emotional and/or cognitive impacts on those users whose notes are not referenced?

- Could the low degree of socio-emotional support along with the large number of un-referenced notes in such courses affect the attrition rates in this medium?

In this analysis, the note that was most frequently referenced contained directions from the instructor regarding procedures for conducting the assignment. However, other notes frequently referenced generally introduced new themes into the conference.

Issues arising from these observations are:

- How do procedural strategies used by the moderator affect the cognitive interactions that occur between participants in online courses?

- What impact would it have on interactions if participants in the same conference take on procedural responsibilities?

- Are cognitive interactions stimulated when new ideas are generated in the conference?

- Are there differences in the characteristics of the notes written which stimulate users in responding to specific notes and not others? This could include the type of language used, the use of examples, verbosity of participant, etc.

- Can this selective referencing of notes by participants lead to the establishment of "electronic" leaders in online groups?

The results show that the majority of messages sent in the conference were generated by the participants in response to topics raised in the readings as opposed to the discussion of the specific concepts identified in the assigned readings. However, in both instances knowledge acquisition strategies were most frequently used in interacting with the messages. A closer investigation of processes used on the themes shows that elaboration strategies were more frequently used with those themes raised by participants than those raised from the readings. These observations prompt the following questions:

- What features of assigned readings and new information generated in discussions catalyse the use of knowledge acquisition strategies?

- Do assigned readings help to generate other knowledge building strategies such as evidenced in the higher user of elaboration and knowledge integration strategies in discussing themes raised by participants?

- If yes, then how do these knowledge building processes from electronic text compare to those generated from traditional text-based materials?

One of the perceived limitations on computer conferencing for online education is thought to be its inability to facilitate certain types of learning,

especially those which depend on face-to-face interaction and/or those aimed at developing specific psycho-motor skills. The results of this investigation appear to support this perception since specific strategies which facilitate the knowledge building process were not used in this online conference. These strategies fell under all of the categories identified with knowledge integration being least facilitated cognitive interaction. Some of the issues that need to be addressed from these findings are:

- How does the nature of the task affect the knowledge building process in online courses? For example, does group discussion facilitate the knowledge building process more than the preparation of a final paper by a group of learners?

- How do the characteristics of the learning situation such as group composition, individual learning characteristics, and the role of moderator impact on the types of learning strategies and outcomes of online education?

- How can different instructional designs of online courses more or less facilitate the use of knowledge building processes? For example, do full group seminars more readily facilitate knowledge building than small group seminars or learning dyads?

- Is the knowledge building process in online courses more or less effective with the use of structured designs were readings are assigned as opposed to conferences in which there is an open structure with no common materials to guide the discussion?

The use of hypertext and information management systems in the analysis on online interaction has given substance and form to what were previously vague concepts on the manner in which learning is facilitated in online education applications. But in so doing, it has demonstrated that there are several issues the dealing with the role of structure and process in online learning that need to be researched. It is by conducting further investigations on these issues that educators can help to fully maximise on the power and flexibility of computer conferencing systems for educational purposes.

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APPENDIX A.

GLOSSARY OF SEMANTIC DESCRIPTORS FOR THEMES.

TERMS	MEANINGS.
asynchronous communication	the impact of asynchronous communication on learning with computer-mediated communications.
electronic university	the role of CMC for delivering university education to learners.
on-line interactivity	the level of interaction that is facilitated between users in on-line courses
role of the instructor [ROI]	role of the instructor in on-line courses.
feedback with CMC [FWC]	the types of feedback that participants in an on-line course get from the instructor or other participants.
socio-economic levels	the socio-economic levels that participants must be at to afford doing on-line courses.
information overload [IO]	the process whereby the participant in an on-line course feels overloaded with the volume of information that must be managed in a conference.
metacognition [MCN]	the role that on-line courses plays in enhancing the metacognitive processes of the learner.
verbosity	refers to the length of the notes sent by participants in online conferences.
electronic training	the role that CMC could play in training be it for professional development or for academic advancement.
entry skills of users	the skills that a learner coming to the new medium should have to maximise on the learning process.
suitability of the medium [SOME]	represents the inherent functionalities and design capabilities of conferencing environments which facilitate the learning process.

costs	refers to the exact costs for doing various online courses with different universities.
role of the learner [ROL]	the role that the learner assumes in on-line courses as compared to the traditional class room situation.
technical support [TECHPORT]	the technical support that users must have if they choose to run on-line courses for their students.

APPENDIX B.

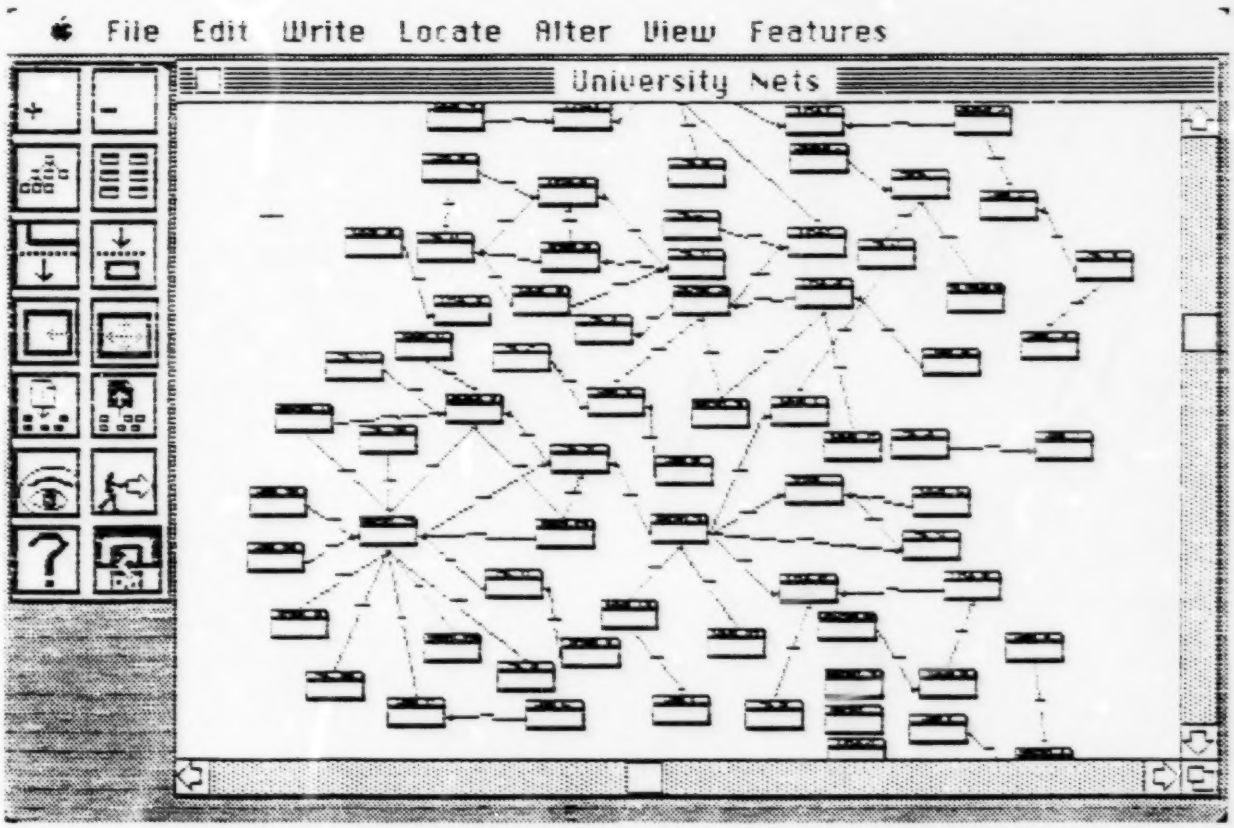
GLOSSARY OF KEYWORDS FOR INTERACTION PROCESS.

KEYWORDS	DEFINITIONS
questions	represents the explicit asking of questions by participants in the conference.
clarification	the process whereby a participant explained concept(s) raised by themselves in the conference.
illustration	the process whereby a participant explained concept(s) raised by themselves in the conference and uses comparisons to help explain the point of view.
exemplification	the process whereby a participant explained concept(s) raised by themselves in the conference and uses examples to help explain the point of view.
elaboration	here a participant developed in greater detail a specific concept that is raised by others or by the participant in the conference.
summarisation	the process whereby the user condensed the main points raised on a particular concept in the entire conference.
substantiation	this is the process whereby a user provides information which helps to verify a point of view raised on a concept in the conference.
synthesis	the process whereby the user has introduced a new perspective on a particular concept by condensing all opinions of a concept raised in the conference.
new point	here the participant merely introduces a new point without referring to other messages in the conference.
new perspective	here the participant introduces a new perspective based on a particular opinion already given in the conference.
acceptance	here the user merely refers to another participant's note without stating explicitly whether he/she agrees with what is stated in the message.

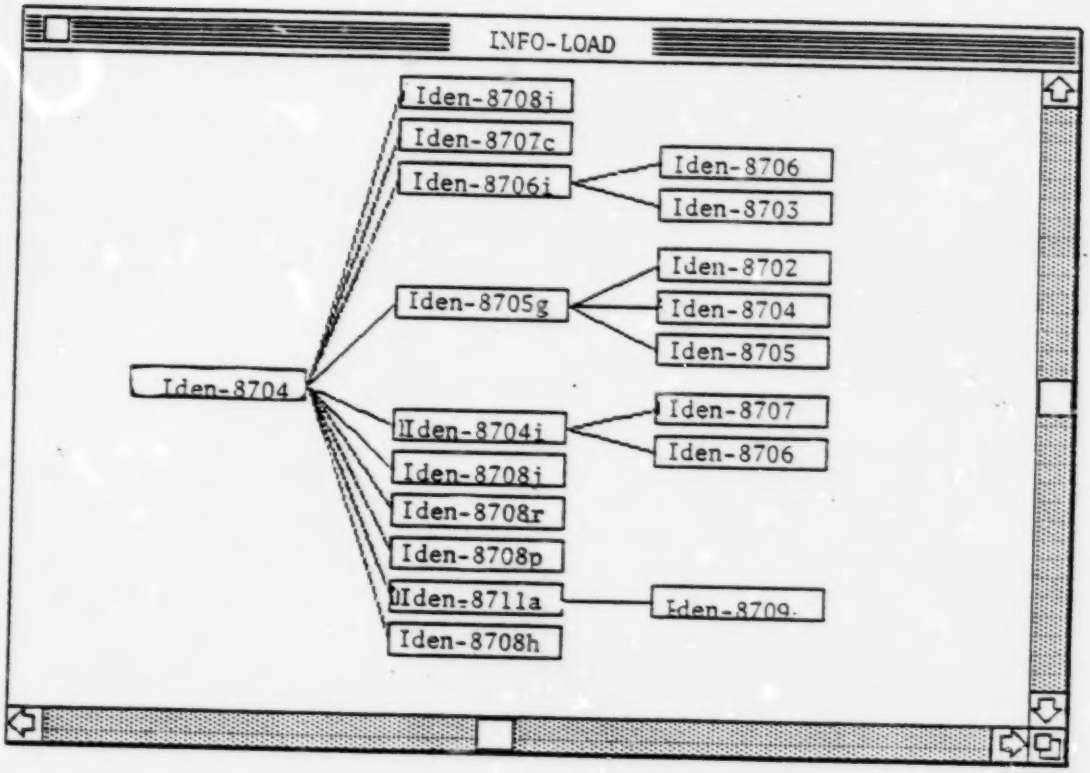
agreement	the process in which a participant overtly expresses the same opinion on a specific concept as another writer.
extrapolation	the process whereby the user makes an inference on the manner in which CMC could be used in an application apart from those raised in the conference.
answer	the user simply responds to a specific question raised by a participant in the conference.
catalysing	the process whereby a message is introduced into a conference with the sole purpose of creating greater discussion of specific areas of a given concept. The process could also be called seeding and is a strategy that could be used by the facilitator.
states a position	here the participant merely gives an opinion on a given concept without reference to other messages in the system.
positive reinforcement	here a participant gives positive feedback directly to another user in the conference.

APPENDIX C.

Pictorial representation of Interaction Analysis in STORYSPACE.



Pictorial representation of a Theme discussed in the Conference.



APPENDIX D.

Hierarchical representation of Interaction Analysis in IZE.

Hierarchical Arrangement of Interaction Processes.

Outline of "States a new position"

I. Position

A. Electronic University

1. Iden-8702 >
2. Iden-8706b >
3. Iden-8705c >
4. Iden-8705b >
5. Iden-8705a >
6. Iden-8701 >
7. Iden-8701c >
8. Iden-8704a >

B. Electronic training

1. Iden-8706d >
2. Iden-8708a >

C. Suitability of the medium

1. Iden-8707b >
2. Iden-8711a >

D. (others) {2}

Outline of "generating inferences"

I. Generating Inferences

A. Electronic training

1. Iden-8705c >
2. Iden-8708c >
3. Iden-8705i >
4. Iden-8704l >
5. Iden-8704k >
6. (others) {2}

B. Role of the instructor

1. Iden-8705f >
2. (others) {3}

C. Information overload {3}

D. Asynchronicity of the medium {2}

E. Iden-8708d interactivity >

F. Iden-8708f socio-economic levels of participants >

G. Iden-8708o verbosity of participants >

H. (others) {3}

Hierarchical Arrangement of Themes Discussed.

Outline of "electronic training"

I. Electronic training

2b[A. Generate Inferences]

1. Iden-8705c >
2. Iden-8708c >
3. Iden-8705i >
4. Iden-8704l >
5. Iden-8704k >
6. Iden-8704f >
7. Iden-8704b >

B. Position {2}

C. Iden-8701e catalysing > >

D. Iden-8705d extrapolation >

E. Iden-8709a introduces a new perspective >

F. Iden-8701c introduces a new point >

G. Iden-8704m synthesis >

H. Iden-8706k answers a question >

I. (others) {2}

Outline of "information overload"

I. Information overload

A. Generates inferences

1. Iden-8708j >
2. Iden-8707c >
3. Iden-8706i >

B. Clarification

1. Iden-8705g >
2. Iden-8704i >

C. Extrapolation

1. Iden-8708j >
2. Iden-8708r >

D. Summarisation

1. Iden-8708p >
2. Iden-8711a >

E. Iden-8708h point >

APPENDIX E.

TABLE I: The frequency with which notes in the conference were referenced

INTER-MESSAGE REFERENCING

MESSAGE REFERENCED (#)	(f)	MESSAGE REFERENCED (#)	(f)
0	22	26	3
1	4	28	1
3	3	31	4
4	3	33	3
5	3	34	4
6	3	35	1
7	1	36	1
9	3	37	1
10	3	38	1
11	1	40	3
12	2	42	1
13	1	43	1
14	4	44	12
15	3	46	3
16	12	56	1
17	4	61	1
18	2	67	1
20	2		
27	1		
T O T A L	77	T O T A L	42

APPENDIX F.

TABLE II: The frequency with which themes were discussed in the conference analysed.

THEME	f	%
* Electronic University	10	9.61
* Interactivity	2	1.92
Electronic Training	18	17.31
Entry level skills	4	3.84
Suitability of the medium	11	10.58
* Asynchronicity of the medium	5	4.80
Costs	6	5.76
Socio-economic levels of users	3	2.88
* Role of the instructor	14	13.46
Feedback with CMC	5	4.80
Role of the learner	3	2.88
Metacognition	7	6.73
Verbosity of participants	2	1.92
Technical Support	2	1.92
Information Overload	10	9.61
* Adopting course structure	1	0.96
* Proposing course structure	1	0.96
TOTAL	104	
* Concepts raised from readings	33	31.73
Concepts raised in conference	71	68.26

APPENDIX G.

TABLE III: The frequency with which interactions processes were used in the conference analysed.

INTERACTION PROCESSES	f	%
@ States position	14	13.46
@ Introduces a new point	9	8.65
& Positive Reinforcement	1	0.96
$ Generates Inferences	21	20.19
@ Agrees with new point raised	9	8.65
@ Asks a question	6	5.76
@ Introduces a new perspective	5	4.81
@ Accepts a stated perspective	3	2.88
@ Answers a question	4	3.84
^ Extrapolation	6	5.76
^ Exemplification	1	0.96
^ Substantiation	3	2.88
^ Clarification	3	2.88
^ Synthesis	7	6.73
* Catalysing	4	3.84
$ Summarisation	5	4.81
$ Illustration	2	1.92
* Propose course format	1	0.96
* Adopt course format	1	0.96
TOTAL	104	
@ KNOWLEDGE ACQUISITION	49	47.12
^ KNOWLEDGE INTEGRATION	20	19.23
$ ELABORATION	28	26.92
& SOCIO-EMOTIONAL	1	0.96
* PROCEDURAL	6	5.76

APPENDIX H.

TABLE IV: The frequency with which interactions processes were used for each learning category identified.

INTERACTION PROCESSES	CATEGORY	TOTAL	% of cog. proce	% of confer.
COGNITIVE INTERACTIONS	Knowledge Acquisition	49	50.52	47.12
	Knowledge Integration	20	20.62	19.23
	Elaboration	28	28.86	26.92
TOTAL		97		93.26
SOCIO-EMOTIONAL INTERACTIONS	Positive Reinforcement	1	100%	0.96
TOTAL		1		0.96
PROCEDURAL INTERACTIONS	Catalysing	4	66.66	3.84
	Influencing Course Format	2	33.33	1.92
TOTAL		6		5.76

APPENDIX I.

TABLE V: The frequency with which interactions processes were used with each theme in the conference analysed

THEMES	INTERACTION PROCESSES	F	% of confer.
ELECTRONIC UNIVERSITY	States a position	8	7.69
	+tive reinforcement	1	0.96
	Generate inferences	1	0.96
	TOTAL	10	9.61
INTERACTIVITY	Introduces perspect.	1	0.96
	Generate inferences	1	0.96
	TOTAL	2	1.92
ELECTRONIC TRAINING	Generate inferences	7	6.73
	States a position	2	1.92
	Introduces perspect.	1	0.96
	Extrapolation	1	0.96
	Introduces a point	1	0.96
	Catalysing	2	1.92
	Summarisation	1	0.96
	Answers a question	1	0.96
	Propose structure	1	0.96
	Synthesis	1	0.96
	TOTAL	18	17.31
ENTRY LEVEL SKILLS	Asks a question	2	1.92
	Introduces a point	1	0.96
	Answers a question	1	0.96
	TOTAL	4	3.84

TABLE III continued.

THEMES	INTERACTION PROCESSES	F	% of confer.
SUITABILITY OF THE MEDIUM	Agrees with point	5	4.80
	States a position	2	1.92
	Exemplification	1	0.96
	Synthesis	1	0.96
	Catalysing	1	0.96
	Summarisation	1	0.96
	TOTAL	11	10.58
ASYNCHRONICITY	Generate inferences	2	1.92
	States a position	1	0.96
	Extrapolation	1	0.96
	Synthesis	1	0.96
	TOTAL	5	4.80
COSTS	Asks a question	2	1.92
	Introduces a point	1	0.96
	Substantiation	1	0.96
	Answers a question	1	0.96
	Illustration	1	0.96
	TOTAL	6	5.76
SOCIO-ECONOMIC LEVELS	Introduces a point	1	0.96
	Clarification	1	0.96
	Generates inferences	1	0.96
	TOTAL	3	2.88

TABLE III continued.

THEMES	INTERACTION PROCESSES	F	% of confer.
ROLE OF THE INSTRUCTOR	Generates inferences	4	3.83
	Introduces perspect.	3	2.88
	Substantiation	2	1.92
	Accepts perspective	2	1.92
	Asks a question	1	0.96
	Synthesis	1	0.96
	Illustration	1	0.96
	TOTAL	14	13.46
FEEDBACK WITH CMC	Introduces a point	1	0.96
	Generates inferences	1	0.96
	Accepts perspective	1	0.96
	Agrees with point	1	0.96
	Summarisation	1	0.96
	TOTAL	5	4.80
ROLE OF THE LEARNER	Introduces a point	1	0.96
	Synthesis	1	0.96
	Agrees with point	1	0.96
	TOTAL	3	2.88
VERBOSITY OF PARTICIPANTS	Introduces a point	1	0.96
	Generates inferences	1	0.96
	TOTAL	2	1.92

TABLE III continued.

THEMES	INTERACTION PROCESSES	F	% of confer.
METACOGNITION	Introduces a point	1	0.96
	Synthesis	2	1.92
	Extrapolation	1	0.96
	Agrees with point	1	0.96
	Catalysing	1	0.96
	Generates inferences	1	0.96
	TOTAL	7	6.73
TECHNICAL SUPPORT	Asks a question	1	0.96
	Answers a question	1	0.96
	TOTAL	2	1.92
INFORMATION OVERLOAD	Generates inferences	3	2.88
	Clarification	2	1.92
	Summarisation	2	1.92
	Extrapolation	2	1.92
	Introduces a point	1	0.96
	TOTAL	10	9.61
PROPOSING COURSE STRUCTURE	Introduces a new Perspective	1	0.96
	TOTAL	1	0.96
ADOPTING COURSE STRUCTURE	Agrees with new perspective	1	0.96
	TOTAL	1	0.96